HES – Coastal Waters (CW) Concept

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GOES-R Industry Day

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Outline

- Background: Outgrowth of earlier instruments
- HES-CW parameters

Background

- HES-CW task can be met by a separate instrument or a combined instrument. The government has no preference.

- MIT-LL HES –CW concept is outgrowth of earlier NOAA studies
  - Studies for the GOES-N Instrument of Opportunity (IOO) slot

    Extended Special Event Imager (ESEI), a NASA proposal, based on both work by NASA and on the Special Event Imager (SEI) point design for GOES by MIT-LL

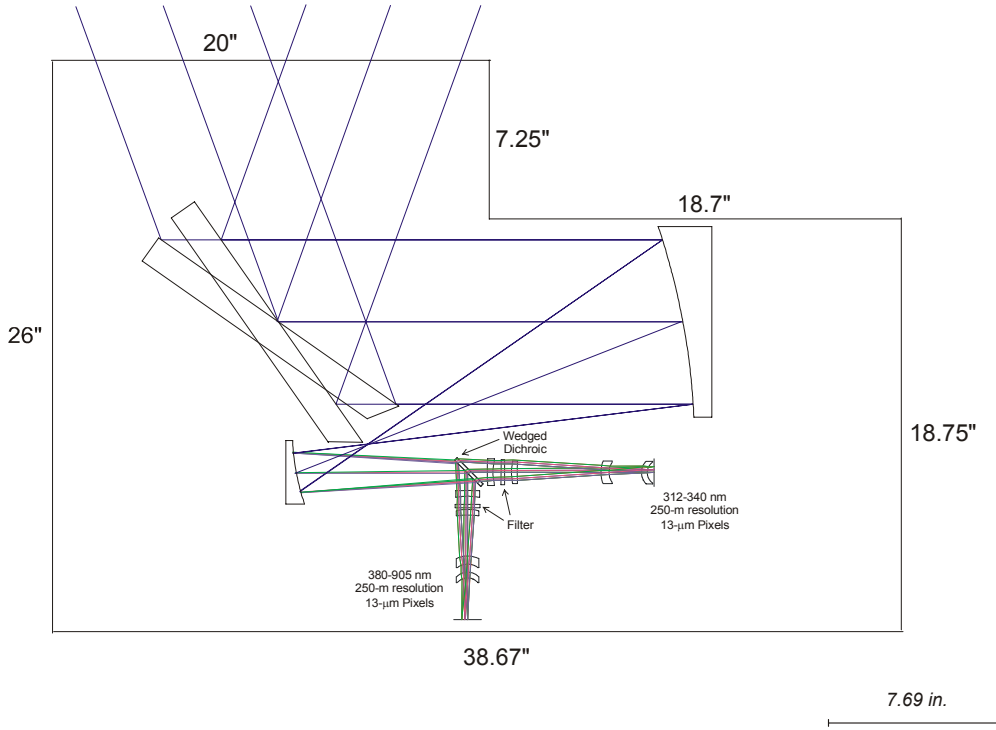
    Hyperspectral Imager (HSI) point design for GOES by MIT-LL
  - Hyperspectral studies at MIT-LL to explore spectral bands and products.

Background: ESEI

- The Special Events Imager (SEI) was originally proposed to NOAA/NESDIS by Lincoln in the winter of 1998
  - Designed as a separate instrument to remove conflicts when imaging storms
  - Finer resolution than imager
- Addition of bands for NOAA ocean scientists for coastal zone research lead to redesign called Extended SEI (ESEI)
  - Complimented both existing GOES instruments and polar science missions (MODIS, SeaWiFS) by providing better spatial and and better temporal resolution
  - UV-VIS-NIR (312 – 900 nm) imager with 18 color bands, 250 m spatial resolution (nadir) and < 1 minute temporal update rate
    - Filter wheel instrument
    - Step and stare

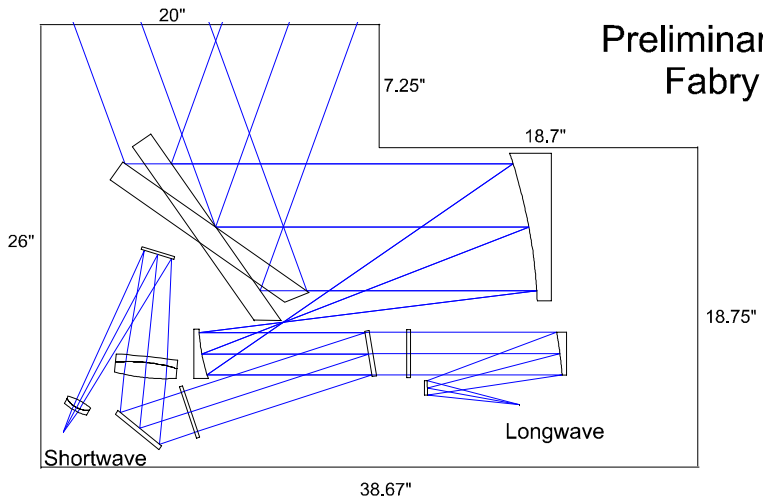
Background: ESEI Design

- 7.5 inch (19 cm) aperture
- Off-axis optical system for low scattered light
- Dichroic to split band between UV and VIS/NIR detectors
- Dual Orthogonal Transfer CCDS
  - OT required for electronic jitter suppression
  - Both nominally 1024 x 1024 frame transfer devices
- Filter wheels to select band
- Commanded data compression
- Onboard Inertial Reference Unit
  - Required to drive jitter compensation circuitry
  - Required stability to < 7 urad over several minutes for multi-band products



Background: HSI

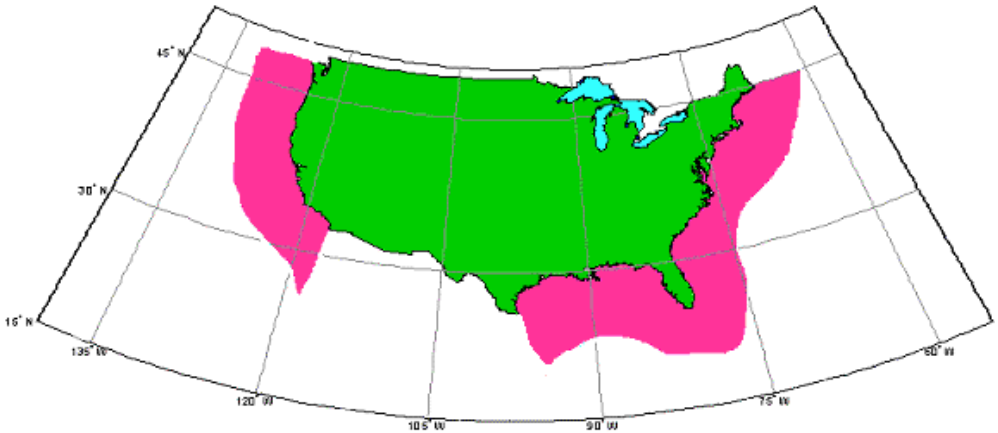
Characteristic	July, 2000 Requirements
Spectral Range	0.4 – 1.7 μm
Spectral Resolution	≤ 0.01 μm
Number of Channels	130
Coverage	3000 km x 5000 km
Dynamic Range	12 bits
Instrument SNR @ 0.5 μm	300
Image Refresh Period	30 min
Downlink Rate	680 kbps
Instrument Mass	25 kg
Instrument Power	< 100 W



Note: More Lenses will be needed.

- **Similar aperture and off-axis telescope to ESEI**
- **Envisioned first as a push-broom system but coverage constraint of CONUS in 30 minutes led to Fabry-Perot step and stare imager**
  - **F-P acquires all spatial pixels simultaneously in a sub-image for one spectral channel**
  - **Collects spectral channels sequentially; collects selected channels**
  - **FPA sized to increase integration time, reduce number of sub-images**
  - **LOS jitter appears as band-to-band registration error; easier correction**

HES-CW Concept



- Total coverage is US navigable waterways
  - At a minimum, this is the region shown above, although rivers and lakes are included.
- However, presence of two HES satellites implies a single HES (East or West) will view only one or the other coast
  - Longer coast is East plus Gulf (~2.4e6 km^2) (TBR) in same one hour, which defines the rate.
- Grating push-broom or step and stare system, with filters or with Fabry-Perot, appear reasonable
  - Threshold is 14 channel coverage
  - Goal is hyperspectral coverage from 0.4 to 1.0 um.

Estimated performance

- ESEI designed for S/N of 400:1 to 800:1 with 250 m resolution
  - Spatial binning for higher signal to noise values
  - Band dependent
  - Used SeaWiFs radiances; considered ~ 2 x high compared to MODIS (polar).
- Higher MODIS SNR values are associated with 1000 m resolution
- Instrument performing HES-CW task requires ≥ 30 cm aperture to get required S/N of 300 (Threshold, TBR), 600 (Goal, TBR).
  - Spatial binning would provide improved S/N for improved science performance but acceptability of this is under review
  - If spatial binning is not permitted, achieving goal S/N (TBR) will require the larger aperture.

HES-CW instrument parameters

- **Concept estimate**
  - **Mass: < 80 kg** **(ESEI and HSI meet this)**
  - **Power: < 100 W** **(ESEI and HSI meet this)**
  - **Volume: 1.3 m x 1.0 m x 1.0 m** **(ESEI and HSI meet this)**
  - **Data rate**

    Sending down all of the data all of the time may prove taxing on the future X-band communications system.

    Therefore assuming transmission to ground based on science for each type of observation

    Observation of red tides, chlorophyll, optical depth, etc. will send down the relevant 5 or fewer band for the observation.

    Data rate estimate is 1.4 Mbps

HES-CW summary

- Concept based on two earlier design but scaled to meet the HES-CW requirements

- Will provide valuable coverage of the properties of the coastal and shelf waters with the rapid update afforded by a geosynchronous platform.